CHAPTER 8

OTHER AUXILIARY EQUIPMENT

This chapter provides general information on the maintenance and repair of a variety of auxiliary machinery that you will be called upon to repair, replace, or adjust. Auxiliary machinery includes controllable pitch propellers, low-pressure steam drain systems, high-pressure steam drain systems, distilling plants, hydraulic systems, external hydraulics, hydraulic cargo hatch covers, boat davits, bow ramp and door machinery, elevators, conveyors, cranes, dumbwaiters, and escalators. You as an EN3 must have already completed personnel qualification standards (PQSs) on some of this auxiliary equipment.

CONTROLLABLE PITCH PROPELLERS

This section will discuss some general facts about the maintenance and repair of controllable pitch propellers. For more information you can refer to technical manual system-oriented instructions, *Controllable Pitch Propellers*, *LST 1182* through *LST 1198,* NAVSEA 0944-LP-007-1018, or *Maintenance Manual for Controllable Pitch Propellers in DD-963 Class, DDG-993 Class, and DD-997 Class*, S9245-BF-MMM-010.

Keeping the hydraulic system clean is of the greatest importance. During a dismantling, there is always a possibility of foreign matter entering the system. You must avoid any unnecessary dismantlings as long as the system is working satisfactorily. If the system or a part has to be dismantled, you must be sure that all parts and pipes are clean before reassembling.

Wipe up any oil or dirt found on or near the hydraulic valve manifold, the oil distribution (O.D.) box, or the control plate assembly. Keep bilge water levels below the lower oil tank manhole cover. And, if possible, keep bilge water below the O.D. box shaft packing glands. Check all fittings and locking devices periodically to be sure they have not vibrated loose. Lubricate all moving parts weekly and wipe up excess oil. Periodically check the water near the stem of the ship for oil slicks that could result in oil leakage from hub or blade seals. Very minor leaks can be detected on the surface of the water. Follow the maintenance according to the maintenance requirement cards (MRCs). Make sure the MRCs are all tailored for your equipment. If you find an error, you must submit a feedback report.

LOW-PRESSURE STEAM DRAIN SYSTEMS

Service steam (low-pressure) drainage systems collect the uncontaminated drains from low-pressure (below 150 psi) steam piping systems and steam equipment outside the machinery spaces. Space heaters as well as equipment used in the laundry, the tailor shop, and the galley are typical sources of drains for the service steam drainage system. Aboard some ships, these drains discharge into the most conveniently located freshwater drain collecting tank. On other ships, particularly large combatant ships, such as carriers, the service steam drains discharge into special service steam drain collecting tanks located in the machinery spaces. The contents of the service steam drain collecting tanks are discharged to the condensate system. In addition, each tank has a gravity drain connection to the freshwater drain collecting tank and to the bilge sump tank located in the same space.

Notice that the service steam drainage system collects only clean drains that are suitable for use as boiler feed. Contaminated service steam drains, such as those from laundry presses, are discharged overboard.

Service steam drain system components consist of various pipings, steam traps, valves, and flanges. In the event you need to make repairs on this system, make sure the system is properly tagged. If needed you can request assistance from the Hull Technicians, who are well trained for this job.

HIGH-PRESSURE STEAM DRAIN SYSTEMS

High-pressure drainage systems generally include drains from superheater headers, throttle valves, main and auxiliary steam lines, steam catapults (on carriers), and other steam equipment or systems that operate at pressures of 150 psi or more. The high-pressure drains aboard some ships lead directly into the deaerating feed tank (DFT). Aboard some newer ships, the high-pressure drains empty into the auxiliary exhaust line just before the auxiliary exhaust steam enters the DFT. In either case, the high-pressure drains end up in the DFT.

These systems have basically the same components as the low-pressure steam drain systems. Components specifically designed for high-pressure steam and the addition of orifices are the only major differences. Whichever system is to be repaired, the system must be tagged. When dealing with repairs on both low-pressure and high-pressure steam systems, there should be a controlled work procedure package. You should review the QA manual concerning repairs on steam systems. Remember you can request assistance from the personnel who are trained to do the repairs. For more general information concerning steam plants, read *Boiler Technician 3&2,* NAVEDTRA 10535-H.

DISTILLING PLANTS

This section will deal with inspections, troubleshooting, and repairing of low-pressure steam distilling plants. The two most common types used by the Navy are the submerged-tube and the flash-type distilling plants. Additionally, this section will mention some facts about the heat recovery type of distilling plant the Navy also uses.

SUBMERGED-TUBE PLANTS

Low-pressure submerged-tube distilling plants differ from ship to ship, but the operating conditions and the maintenance procedures are basically the same. In almost all instances, the personnel who stand watches on the distilling plants are also responsible for the maintenance of the plants. When operating problems do occur, it is the responsibility of the EN2, ENl, or ENC on duty to locate the trouble and to make the necessary adjustments or repairs.

Distilling plant reliability and consistent operating conditions are essential for satisfactory results. Except under emergency conditions, no plant should be forced beyond its rated capacity. Requirements for higher steam pressures result in higher temperatures, which will cause more rapid scaling of the evaporator tubes.

During operation, the various elements of any plant depend on the heat and fluid balances throughout the plant. Adjustment of any one control can produce widespread changes to these balances. For example, an increase in the feed to the first effect will raise the liquid level in the first effect. More heat will be required to raise the feed to the boiling point, so that less heat will be available for evaporation in the first-effect shell and a smaller amount of heat will flow to the second-effect tube nest. These changes produce a new balanced condition, and other adjustments would be required to make the new balance satisfactory. Under such circumstances, overcontrolling could require many readjustments. The operator will always find it better to make small adjustments, one at a time. This will allow enough time between each adjustment for all the conditions to become steady.

Causes of Low Plant Output

Failure to obtain full rated capacity is one of the most frequent problems encountered during the operation of a distilling plant. The problem may be very difficult to remedy since it may result from a combination of things. Adecrease in the distilling output efficiency may result if any of these factors are not met. Full output requires the following:

1. Proper steam pressure above the orifice
    a. Ample steam supply
    b. Proper operation of reducing valves
2. Highest possible vacuum in the first-effect tube nest
    a. No air leaks
    b. Proper water levels in the evaporator shells
    c. Continuously vented evaporator tube nests
    d. Reasonably clean evaporator tube nests
        (1) Continuous feed treatment
        (2) Mechanically cleaned tubes
    e. Density of brine overboard not over 1.5/32
        (1) Reasonably clean overboard piping
        (2) Proper valve settings
        (3) Proper operation of brine pump (clean piping and strainers, proper speed and direction of rotation, properly vented pump, properly packed and sealed gland, and no air leaks in the piping)
    f. Properly drained tube nests
        (1) Proper operation of all drain regulators
        (2) Proper operation of the tube nest drain pump
3. Highest possible vacuum in the last-effect shell
    a. No air leaks

b. Proper air ejector operation

(1) Clean nozzle and strainer

(2) Correct quality and quantity of steam

c. Ample flow of circulating water

(1) Clean strainer, pipeline, and tubes

(2) Proper valve settings

(3) Proper operation of the circulating pump

d. Effective surface in the distilling condenser

(1) No undue deposits inside the tubes

(2) Proper venting of the condenser

(3) Proper operation of the condensate pump

Steam Pressure

A distilling plant cannot maintain its full output unless it is supplied with dry steam at the designed pressure. The orifices were constructed to pass the proper amount of steam plus about 5 psig pressure to safely produce the designed plant output. Orifices should be inspected annually. An orifice should be measured and the reading compared with the figure stamped on the plate. If necessary, the orifice should be renewed.

If the steam pressure above the orifice varies, the exact source of trouble should be located and corrected. First the weight-loaded regulating valve and then the pressure-reducing valve (if installed) should be checked to determine whether or not each valve is operating properly. If they are functioning properly and the pressure cannot be maintained above the orifice, you may assume that an insufficient amount of steam is being supplied to the plant.

The auxiliary exhaust steam supply for the distilling plants, after passing through the regulating valve, is usually slightly superheated because of the pressure drop through the reducing valve and the orifice plate. A small amount of superheat has little or no effect on the plant operation or the prevention of scale formation. However, when live steam must be used, the installed desuperheater spray connection should be used to control the superheat. The water for desuperheating must be taken from the boiler feed system, preferably from the first-effect tube nest drain pump. Water for desuperheating must NEVER be taken directly from the fresh water distilled by the distilling plant.

Fluctuations in the first-effect generating steam pressure and temperature cause fluctuations of pressure and temperature throughout the entire plant. With increased salinity of the distillate, the fluctuations may cause priming, as well as erratic water levels in the shells. These fluctuations may he eliminated by proper operation of the automatic pressure regulators in the steam supply line.

First-Effect Tube Nest Vacuum

The range of the pressure maintained in the first-effect tube must be between 16 inches of mercury (in.Hg), with clean tubes, to 1 to 2 in.Hg as scale forms. The output of a submerged-tube type of distilling plant is not greatly reduced until the deposits on the tubes have caused the vacuum to drop to about atmospheric pressure. When the first-effect tube nest vacuum is lost entirely, the reduction in output becomes very great. Assuming the reduction in vacuum is due to scale and not to improper operating conditions, the tubes must be cleaned.

Keeping the vacuum in the first-effect tube nest as high as possible reduces scale formation to a minimum, enabling the plant to'operate at full capacity.

A vacuum reduction that results from any factor other than deposits on tube surfaces should be corrected to reduce deposits and greatly extend the intervals between cleanings. The primary factors affecting the first-effect tube nest vacuum are air leakage, low water levels in the evaporator shells, improper venting of the evaporator shells, scale or other deposits on the tubes, and improper draining of the evaporator tube nests.

Loss of vacuum resulting from deposits on evaporator tubes should be gradual. Under normal conditions, there will be no major loss of vacuum for any one day's operation. Any sudden drop in vacuum can be traced to causes other than scale deposits.

The generating steam circuit operates under vacuum and is subject to air leaks. Leaks from the steam side of the first-effect tube nest to the first-effect shell space cause losses of capacity and economy. Loss of vacuum and loss of capacity may be due to air leaks. The air leaks may he from the atmosphere into the generating steam line (downstream from the orifice plate); from the first-effect tube nest front header; or from the first-effect tube nest drain piping. Air leaks in this part of the distilling plant may be less noticeable than air or water leaks elsewhere, because the effect on the plant is similar to the scaling of the tube surfaces.

Proper Water Levels

A reduced first-effect tube nest vacuum can result from low water level in any evaporator shell. On older plants, the water levels are controlled by manually regulating the feed valves. On newer plants, the water levels are automatically controlled by weir-type feed regulators. Inability to feed the first effect is usually due either to scale deposits in the seawater sides of the air ejector condenser and the vapor feed heater or to obstructions in the feed line. Inability to feed the second or third effects is due to air leakage or heavy scale deposits in the feed lines between the effects. It is important that you keep the gauge glass and the gauge glass fittings free from scale and air leaks. Air leaks or scale will result in false water level indication readings.

Once the distilling plant is in operation, the feeding must be maintained at a steady rate. A sudden rise of the water levels or too high a water level will cause carryover of small particles of brine within the vapor (priming). Maintain the level of water in the shell at the highest level that can be held and still prevent the carrying over of saltwater particles within the freshwater vapor. If this constant water level is not maintained, scales will form rapidly on the exposed tube surfaces.

The pressure differential between the first and second effects permits the second-effect feed to be discharged into the second-effect shell. A partial or total loss of pressure differential indicates that air leaks have occurred between the first-effect and second-effect shells in the two-effect distilling plants. Large air leaks between the first effect and second effect can be readily detected, because the vacuum gauge for the first effect will read approximately the same as the vacuum gauge for the second effect. Large air leaks of this type will disrupt the operation of the plant and must be located and repaired before the plant will operate properly.

Improper Venting of Evaporator Tube Nests

Improper venting of the evaporator tube nests can cause either an accumulation of air in the tubes or an excessive loss of tube nest steam to the distilling condenser. A loss of tube nest air or steam results in a loss of capacity or a loss of economy. Problems of this type usually result from improper operations, rather than from material failures.

Scale Deposits on Evaporator Tubes

Scale deposits on evaporator tube nests have been a serious cause of operating difficulties. The rate of scale formation is affected by the density of the brine and by the types of solids present in the feed. Although the major constituents of seawater (sodium chloride, magnesium chloride, and others) do not form scale under normal plant operating conditions, they may do so when the last-effect brine density exceeds 1.5/32. The primary scale-fomling constituent of seawater, calcium carbonate, will form scale even under normal plant conditions. But, the rate of scaling depends on the brine density. For this reason, you must maintain the last-effect brine density at 1.5/32.

Another method to control scale formation is by the use of scale preventive compound. This material helps retard scale formation and foaming in distilling plants. The only authorized distiller scale preventive compound for surface ships is DOD-D-24577 (SH), *Distiller Scale Preventive Treatment Formulutions,* available from the Navy Supply System under National Stock Number (NSN) 9G6850-00-173-7243. Ships that were not originally equipped with chemical injection equipment conforming to MIL-P-21397, *Chemical (For Distilling Plants Naval Shipboard Use) Proportioning Unit,* should install such equipment through a ship alteration (SHIPALT). Note that all plants require 24 gallons of solution regardless of plant capacity. You will use 1 pint of scale preventive compound for each 4,000 gallons per day of distilling plant capacity. You must combine the total amount of scale preventive compound in the mixing tank with enough fresh water to make 24 gallons of solution.

WARNING

Concentrated scale preventive compound is strongly alkaline. Avoid contact of the liquid with skin or eyes. Wash hands thoroughly after using. In case of contact with eyes, flush with fresh water for at least 15 minutes and report to sick bay immediately.

Last-Effect Shell Vacuum

A vacuum of approximately 26 in.Hg should be obtained in the last-effect shell when the temperature of seawater is 85°F. The vacuum should be higher when the seawater is colder. Failure to obtain a vacuum of 26 in.Hg, or more, can generally be traced to one of several factors or a combination of these factors. It could be air leaks, improper operation of air ejectors, insufficient flow of seawater, or ineffective use of heat transfer surface in the distilling condenser.

Air Leaks

Many distilling plant troubles are direct results of air leaks. Air leaks in the shells of distilling plants cause a loss of vacuum and capacity. You must take extreme care when making up joints, for they must be kept tight. Periodically test the joints under pressure for leaks. When the plant is in operation, use a candle flame to test all joints and parts under vacuum. When the plant is secured, you can use air pressure or soapsuds for testing.

Air leakage may also be detected by hydrostatically testing the various parts of the plant. You should take the necessary precautions not to exceed the maximum limit of the test pressure specified by the manufacturer.

Saltwater Leaks

Defective tube(s) on the heat exchangers can be located by means of an air or a hydrostatic test. You should follow the recommended procedure according to the manufacturer's instructions.

Air Ejector

The steam pressure at the nozzle inlet of the air ejector must not be less than that for which the ejector is designed (stamped on the nameplate). Pressures at the air ejector nozzles may be 10 to 15 psig higher than the minimum specified by the manufacturer.

The primary causes of air ejector problems are low steam pressure, wet steam, an obstructed nozzle, or a clogged steam strainer. Problems are usually indicated by a failure to obtain or to maintain the required vacuum. If a problem is due to low steam pressure or wet steam, you should increase the steam pressure, install a drainage trap, or devise a manual solution. A clogged nozzle or strainer must be removed and cleaned. You should use special reamers to clean the air ejector nozzles. You should NEVER use a sharpedged tool to clean nozzles! Improper tools will damage the nozzle surfaces and impair the efficiency of the air ejecter.

Procedures for testing air ejectors can be found in the manufacturer's technical manual. In general, the same maintenance procedures should be followed for distilling plant air ejectors as for air ejectors for the main condensers.

You should inspect the air ejector strainer according to the PMS. Failure to keep the strainer clean will cause a reduced or fluctuating vacuum. When a strainer or a nozzle becomes damaged, you should replace it.

Insufficient Circulating Water

An insufficient flow of circulating water is indicated when the temperature of the water rises more than 20°F while passing through the condensing section of the distiller condenser. The last-effect shell pressure is directly dependent upon the distiller condenser vacuum. The vacuum is dependent upon the temperature and quantity of the circulating water and the proper operation of the air ejectors. Too low an overboard discharge temperature of the distiller condenser circulating water is accompanied by efficiency losses in the distilling plant. The overboard discharge temperature should be kept as high as possible, without exceeding the desired 20°F temperature rise through the distiller condenser. In addition, limiting the quantity of circulating water tends to prolong the service life of the tubes and tube sheets. When troubles occur which are not caused by improper operating procedures, you should inspect the condenser circulating water system to determine the true cause of the faulty operation.

You must carry out preventive maintenance procedures to ensure that the circulating water pump is maintained in good material condition. You should also carry out routine procedures to ensure the proper setting and maintenance of the back-pressure regulating valve. A regulating valve that is not working properly must be disassembled and repaired before its faulty operation interferes with the operation of the distilling plant.

You should inspect the condenser circulating water system pipings at regular intervals for cleanliness as well as for scale or foreign matter. The operators of the distilling plant should inspect and clean the strainers according to the PMS.

Improper Drainage

If the distilling plant fails to produce the designed output when the pressure above the orifice is 5 psig and the first-effect tube nest is several inches of mercury, this is an indication of improper drainage of the distiller condenser or of one of the evaporator tube nests subsequent to the first effect. Complete flooding of the flash chamber gauge glass is also a positive indication of improper draining of the condenser. Because the level appears to be in the gauge glass or below is not necessarily an indication of improper drainage. Air leaks at the gauge glass fittings may indicate a false liquid level.

Brine Density

Proper brine density should be maintained at 1.5/32. If the brine concentration is too low, there will he a loss in capacity and economy. If the brine concentration is too high, there will an increase in the rate of scaling of the evaporator heating surfaces.

FLASH-TYPE DISTILLING PLANTS

Many maintenance procedures for flash-type distilling plants are similar to the maintenance procedures required for submerged-tube distilling plants. Both types of plants are subject to air leakage, saltwater leakage, and malfunctioning of pumps and other auxiliary equipment.

HEAT-RECOVERY DISTILLING PLANTS

Heat-recovery distilling plants are single-effect distilling plants with a submerged-tube heat exchanger. This heat exchanger uses heat energy contained in the jacket cooling water circulated through diesel main propulsion engines and ship's service diesel generators. This unit requires no steam for air ejectors because feed is used as the motive power to operate eductors for air and brine removal To supplement the heat in the jacket cooling water when engines are running at low rates, the plant has electric heating modules and steam heaters. This ensures that the jacket cooling water will be at the required temperature when it enters the submerged-tube heat exchanger. The jacket water passes through all the heat exchangers (whether energized or not) to the inlet of the submerged-tube bundle. Here the heat is transferred through the tubes to the feed in the boiling compartment. The jacket water then exits the tube bundle and returns to the engine. The heat-recovery system is fitted with a circulating pump and an expansion tank

Most heat-recovery distillers aboard Navy ships have a secondary heat exchanger between the engine jacket cooling water system and the distiller unit. This heat exchanger isolates the engine coolant, with all its chemical additives, from the distiller. Systems not having this secondary heat exchanger get heat directly from the engine coolant to support the distiller. This is called a single-loop system. A single-loop system must be monitored continuously to ensure that no engine coolant leaks through the distiller submerged-tube heat exchanger. For more information on the monitoring requirements, refer to *NSTM* Chapter 233, "Diesel Engines." For cleaning heat-recovery plants, follow the applicable instructions as you would for cleaning the submerged-tube or the flash-type distilling plants. For more detailed information concerning the distilling units the Navy uses, refer to the manufacturer's manual and *NSTM*, Chapter 531, Volumes 1, 2, and 3, "Desalination Low-Pressure Distilling Plants."

HYDRAULIC SYSTEMS

The overall efficiency of the hydraulic installations used to control or drive auxiliary machines is basically dependent upon the size, oil pressure, speed, and stroke of the hydraulic installation. The efficiency of the hydraulic speed gears and the components of the system will depend upon the care that is given to them. Except for piping and fittings, major repairs of hydraulic gear are generally done in a naval shipyard or by the manufacturers. This section will deal primarily with troubleshooting and preventive maintenance of hydraulic systems, including external hydraulics.

Hydraulic transmissions are sturdy, service-proven machines, inspected and tested with such care that casualties seldom occur. When casualties do occur it is usually the result of faulty assembly, installation, or maintenance. A correctly installed hydraulic system, operated regularly and serviced with proper care, will retain its design characteristics of power, speed, and control. The need for costly repair and replacement will seldom occur if the equipment has been maintained properly.

TROUBLESHOOTING

Troubleshooting an electrohydraulic system involves the systematic elimination of the possible causes, one by one, until the actual cause of a casualty is found. In attempting to locate the source of any trouble in an electrohydraulic system, remember that all troubles fit into one of three categories. It is either hydraulic, electrical, or mechanical. Isolating a trouble into one of these categories is one of the main steps in finding the source of trouble.

Hydraulic Troubles

Casualties in a hydraulic system are generally the result of low oil levels, external or internal leakage, clogged lines or fittings, or improper adjustment of valves and other working parts. Do NOT disassemble a unit unless you are certain that the trouble exists within that unit! Unnecessary disassembly may create conditions that lead to additional trouble, since dirt may enter an open system.

Leaks are a frequent cause of trouble in hydraulic equipment. Generally, leaks are a result of excessively worn parts, abnormal and continuous vibration, excessively high operating pressures, or faulty or careless assembly. External leaks usually have little effect on the operation of equipment other than a steady draining of the oil supply. Even a small leak wastes oil, and the resulting unsightly appearance of a machine is indicative of poor maintenance procedures.

External leaks may result from improperly tightened threaded fittings; crossed threads in fittings; improperly fitted or damaged gaskets; distorted or scored sealing rings, oil seals, or packing rings; scored surfaces of working parts; improperly flared tube ends; or flanged joints not seating squarely.

Internal leaks usually result in unsatisfactory operation of the equipment. Large internal leaks are signified by a loss of pressure and the failure of equipment. While large internal leaks can usually be located by installing pressure gauges in various parts of the equipment, the location of small leaks generally requires disassembly and visual inspection of the parts. Internal leaks may result from worn or scored valves, pistons, valve plates or bushings, or improperly fitted or damaged gaskets.

The most common symptom of trouble in a hydraulic system is an unusual noise. Some noises are characteristics of normal operation and can be disregarded, while others are evidence of serious trouble. Even though the exact sound indicating a specific trouble can be learned only through practical experience, the following descriptive terms will give a general idea of which noises are trouble warnings.

If *popping* and *sputtering* noises occur, air is entering the pump intake line. Air entering the system at this point may be the result of too small an intake pipe, an air leak in the suction line, a low oil level in the supply tank, cold or heavy oil, or possibly the use of improper oil.

If air becomes trapped in a hydraulic system, *hammering* will occur in the equipment or transmission lines. When this occurs, check for improper venting. Sometimes, a *pounding* or *rattling* noise occurs as the result of a partial vacuum produced in the active fluid during high-speed operation or when a heavy load is applied. This noise may be unavoidable under the conditions stated and can be ignored if it stops when speed or load is reduced. If the noise persists at low speeds or light loads, the system needs to be vented of air. Air in a hydraulic system can also cause uneven motion of the hydraulic motors.

When a *grinding* noise occurs, it can usually be traced to dry bearings, foreign matter in the oil, worn or scored parts, or overtightness of some adjustments.

The term *hydraulic chatter* is sometimes used to identify noises caused by a vibrating spring-actuated valve, by long pipes improperly secured, by air in lines, or by binding of some part of the equipment.

Squeals or *squeaks* indicate that the packing is too tight around some moving part or that a high-frequency vibration is occurring in a relief valve.

Electrical Troubles

Even though troubles occurring in electrical equipment are the responsibility of the Electrician's Mate, the Engineman can help maintain the equipment by making a few simple checks when electrical troubles occur. Failure to have a switch in the ON position will cause unnecessary delay in operating electrical equipment. If the switch is closed and the equipment still fails to operate, check for blown fuses or tripped circuit breakers. Troubles of this type are usually the result of an overload on the equipment. If a circuit breaker continues to cut out, the trouble may be caused by damaged equipment, excessive binding in the hydraulic transmission lines, or faulty operation of the circuit breaker. Check for visual indication of open or shorted leads, faulty switches, or loose connections. Do not make repairs to the electrical equipment or system. Do not open enclosures of electrical equipment, but do report evidence of possible electrical failure to the Electrician's Mate.

Mechanical Troubles

When electrohydraulically driven auxiliary machinery becomes inoperative because of a mechanical failure, a check should be made. Look for improper adjustment or misalignment of parts; shearing of pins or keys; or breakage of gearing, shafting, or linkage. Elimination of these causes should be done according to the manufacturer's instructions for the specific piece of equipment.

MAINTENANCE

The principal requirements necessary to keep a hydraulic transmission in satisfactory operating condition are regular operation, proper lubrication, and the required state of cleanliness of all the units and their fluids. Regular operation of hydraulic equipment prevents the accumulation of sludge and the freezing of adjacent parts. Regular use also aids in preventing corrosion. The necessity for proper lubrication and cleanliness cannot be too strongly emphasized

Detailed instructions on the maintenance of a specific unit should be obtained from the appropriate manufacturer's technical manual, but the following general information will also be useful.

The Fluid System

If an inspection of an oil sample drawn from a hydraulic system reveals evidence of water, sludge, or acidity, the system must *be drained,* then *cleaned* with prescribed acid-free cleaning fluid (flushing oil), and *filled* with clean hydraulic oil. A hydraulic system may be drained and cleaned as follows:

1. Remove the permanent filters and wash them in flushing oil. Then use low-pressure air for drying purposes. If the filters have replaceable elements, install new elements.

2. Drain the system of old hydraulic oils as completely as possible.

3. Close all connections, and fill the system with acid-free cleaning fluid.

4. Start andoperate the unit under idling conditions to fill the system thoroughly with cleaning fluid.

5. Secure the unit and allow it to stand idle for the prescribed period (usually about an hour). This period of idleness permits the cleaning fluid to dissolve any sludge.

6. Start and operate the unit with a light load for 3 to 5 minutes, unless otherwise specified. Allow the equipment to stand idle for about 15 minutes, then repeat the whole cleaning process. Do this two or three times.

Never operate a hydraulic unit with a full load when it is filled with cleaning fluid. Keep the operating pressure as low as possible.

7. If time permits, allow the system to stand idle for an additional hour following the series of short operating periods.

8. Drain the system of cleaning fluid. Reclean permanent filters or, if necessary, install new replaceable filters. Close the system, and fill it with the proper hydraulic oil.

As the system is filled, strain the hydraulic oil through a fine wire screen of 180 or 200 mesh. If the oil is not clean, run it through a centrifuge. You should provide adequate protection against dust and moisture entering the system. Moisture should be expelled from the oil before it is poured into a system. Oil with noticeable water content should be rejected or centrifuged

When a hydraulic system is being filled, sufficient hydraulic fluid should be used to completely fill the active parts of the mechanism, leaving no air pockets. Air valves should he opened during the filling process, so that air can escape to the oil expansion box. Be sure the valves are closed tightly after the system has been filled. For more information on hydraulic fluid filtration, read *NSTM,* Chapter 556, "Hydraulic Equipment (Power Transmission and Control)." For additional information on hydraulic fluids, refer to *NSTM,* Chapter 262, "Lubricating Oils, Greases, and Hydraulic Fluids and Lubricating Systems."

Pumps and Motors

Whether the pumps and motors of hydraulic transmission are of the axial or radial piston type, the maintenance procedures, as well as the operating principles, are relatively the same. In general, maintenance information on other types of pumps also applies to hydraulic pumps and motors. For more information concerning hydraulic pumps and motors, read section 2 of *NSTM,* Chapter 556, "Hydraulic Equipment (Power Transmission and Control)."

Neoprene is the most commonly used seal around the shafts of most modern hydraulic pumps and motors, but other types of shaft packing are also used.

On some modern hydraulic transmissions, *shaft stuffing box packing* is of the square-braided pure asbestos type. This packing is easily removed, but you must take care to be sure that it is not replaced too tightly. If properly installed, this packing makes a tight joint when you apply light pressure. If packing wears quickly, the shaft should be inspected for roughness. If a lathe is available, you may be able to eliminate the roughness from the shaft by a finishing cut to smooth the surface. If a lathe is not available, it may be necessary to replace the shaft. Packing should be renewed at prescribed intervals to eliminate the possibility of the packing becoming hard and scoring the shaft. When packing is being replaced, make certain there is a uniform thickness around the shaft. An excess of packing on one side of the shaft will cause breakage. Stuffing boxes should be packed loosely and the packing gland set up lightly to allow adequate leakage for cooling and lubrication. See *NSTM*, Chapter 078, "Gaskets, Packings, and Seals," for more detailed discussion of O-rings and other types of seals for hydraulic system equipment.

There is very little likelihood of poor alignment between the driving and driven members of a hydraulic transmission if the wedges, shims, jacking screws, or adjusting setscrews were properly set and secured when the connecting units were installed. However, when a casualty occurs or a unit is replaced, it is possible for the unit to become misaligned enough to cause severe stress and strain on the coupling and connected parts. Excessive misalignment should be eliminated as soon as possible by replacing any defective parts and by readjusting the aligning devices. If this is not done, pins, bushings, and bearings will wear out too fast and will have to be replaced frequently.

Since there is no end play to either the pump shaft or the motor shaft, flexible couplings are generally used in hydraulic transmissions. Such couplings permit satisfactory operation with a slight misalignment, without requiring frequent renewal of parts.

Pipings and Fittings

If properly installed, the piping and valves of a hydraulic system are seldom a source of a trouble, except for leakage. Some leaks, however, can be serious enough to cause a reduction in the efficiency of the unit. You should make frequent inspections for leakage and take steps to eliminate any leakage found. Guidance and requirements for the installation, inspection, and maintenance of piping and associated fittings are contained in *NSTM*, Chapter 505, "Piping Systems,"

If leaks occur at a flanged joint in the line of a hydraulic system, tighten the flange bolts evenly, but not excessively. If the leaks persist, use the auxiliary gear while the leaking flange is being refitted with copper asbestos or O-ring packing. Be sure the flange surfaces are cleaned carefully before the packing is applied.

CAUTION

Exposure to asbestos fibers is a recognized health hazard. Refer to *NSTM*, Chapter 635, "Thermal, Fire, and Acoustic Insulation," for safety requirements applicable to handling asbestos packing and gaskets.

If certain measures are taken, operation of hydraulic equipment may be continued while leakage repairs arc being made in some parts of the system. When the lines in an auxiliary system leak, they should be valved off from the main line connection to prevent leakage between the two systems. If leaks occur in the pumping connections to the three-way valves of a steering gear installation, the pump can be cut out with the valve, and another pump cut in. If the three-way valves fail to cut out the leaking unit, and it becomes necessary to cut out both pumps of a steering gear installation, the valves may be closed at the ram cylinder. Hydraulic systems will work without pressure control. So by closing the valves in the lines where they join the main piping, leaking pressure control pipes or cylinders can be cut out of the system for repairs.

Expansion lines and replenishment lines in hydraulic systems of older ships are seldom a source of leakage or breakage, since they are not under any appreciable pressure. However, all hydraulic line connections must be maintained intact. in more recent installations, however, replenishing lines are under pressure as much as 300 psi. In these modern installations, the hydraulic systems should not be operated during the repair of these lines.

Relief valves and shuttle valves of a hydraulic system may also be a source of trouble. The seats of relief valves that are leaking should be reground. Loss of power is a symptom of a leaking relief valve. Shuttle valves may stick and fail to cut off. This condition is evidenced either by the escape of oil from the high-pressure side of the line into the expansion tank or by the failure of the pressure control. When a shuttle valve fails to operate, the stop valves should be closed and the defective valve removed and repaired.

Incorrectly adjusted needle valves can be another source of trouble. Needle valves that are adjusted too fine may cause the device operated by the valve to stop short of its intended stopping point. This may happen because the valve adjustment allows more fluid to pass through leakage points in the system than through the valve. *NSTM*, chapter 556, provides a good source of general information concerning different types of valves used in hydraulic systems and their maintenance.

HYDRAULIC CARGO HATCH COVERS

Cargo hatch cover opening and closing operations are supplied by an electrohydraulic power unit. The system consists of an electric motor-driven hydraulic pump mounted on a hydraulic fluid reservoir tank and an air-driven hydraulic intensifier. Adjacent to the power unit is a hydraulic fluid control valve panel. An emergency air-hydraulic pump is also provided with the system. Fluid pressure is transmitted to either the undogging or dogging side of the hydraulic cylinders. You must read the specific manufacturer’s manual or NAVSEA 0916-LP-018-2010, Hydraulic Operated Cargo Hatch Cover, to understand the full details of the system. Along with this, you should trace the system in your ship and complete the required PQS. During repairs, follow the procedures specified by the PMS.

BOAT DAVITS

Gravity davits are found on most Navy ships. Figures 8-1, 8-2, and 8-3 illustrate the types of gravity davits that you will be maintaining.

For general information about boat davits, read *Boatswain's Mate,* Volume 1, NAVEDTRA 10101. You, as the maintenanceman, must also be familiar with the proper operation of the boat davit. Some common problems with the boat davit are rusting of parts, loss of lubrication, contaminated oil in the gearcase, and faulty centrifugal brakes. Because of the location of the boat davit on the weather deck, the machinery is highly exposed to sea spray, even though it is covered by protective covering. You must lubricate the boat davit and winch after adverse weather conditions. For maintenance and repair of the boat davit, follow the PMS assigned for this machinery. If your ship is equipped with a double-pivoted link davit and a 50-hp winch, NAVSHIPS 0920-072-1013 provides information concerning maintenance instructions. Your work center PMS Manual 43P1, under Maintenance Index Page should provide you with the correct reference publications for each piece of equipment.

BOW RAMP AND DOOR MACHINERY

The ramp and door system consists of the bow ramp, bow doors, tracks, winches with their wire rope rigging, fixed and positive guidance rollers, vangs, seating device, pivot post, control consoles, various interlock and limit switches, and the interlock control panels.

In time, repairs will become necessary to correct the results of wear or to repair damage caused by various casualty conditions. You must know and use the correct sources of information necessary to efficiently disassemble and reassemble the machinery. You must

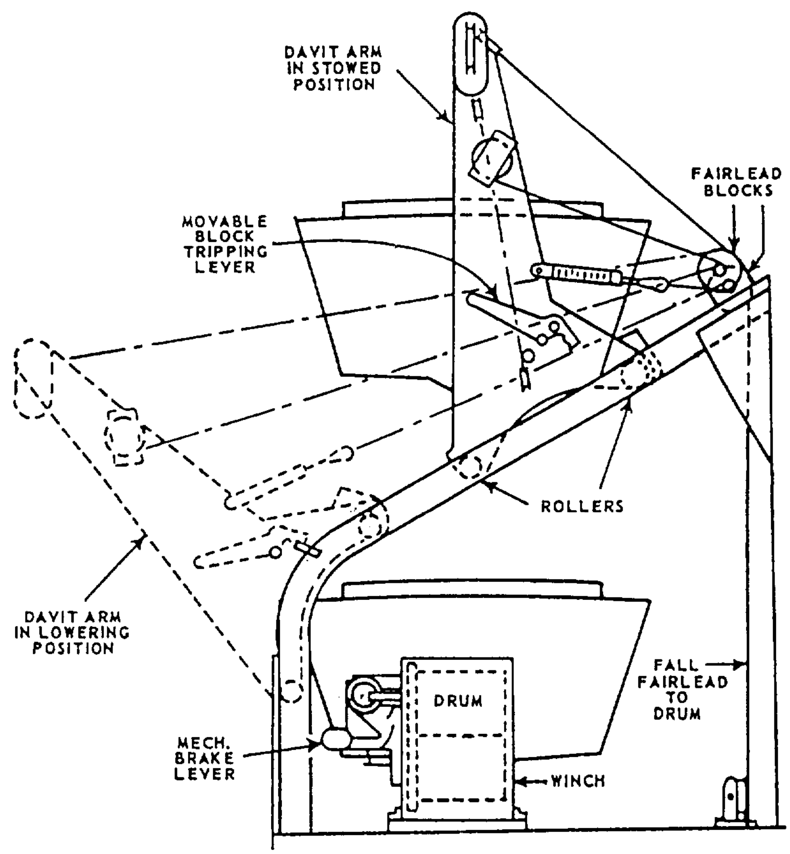

Figure 8-1.—Trackway gravity davit.

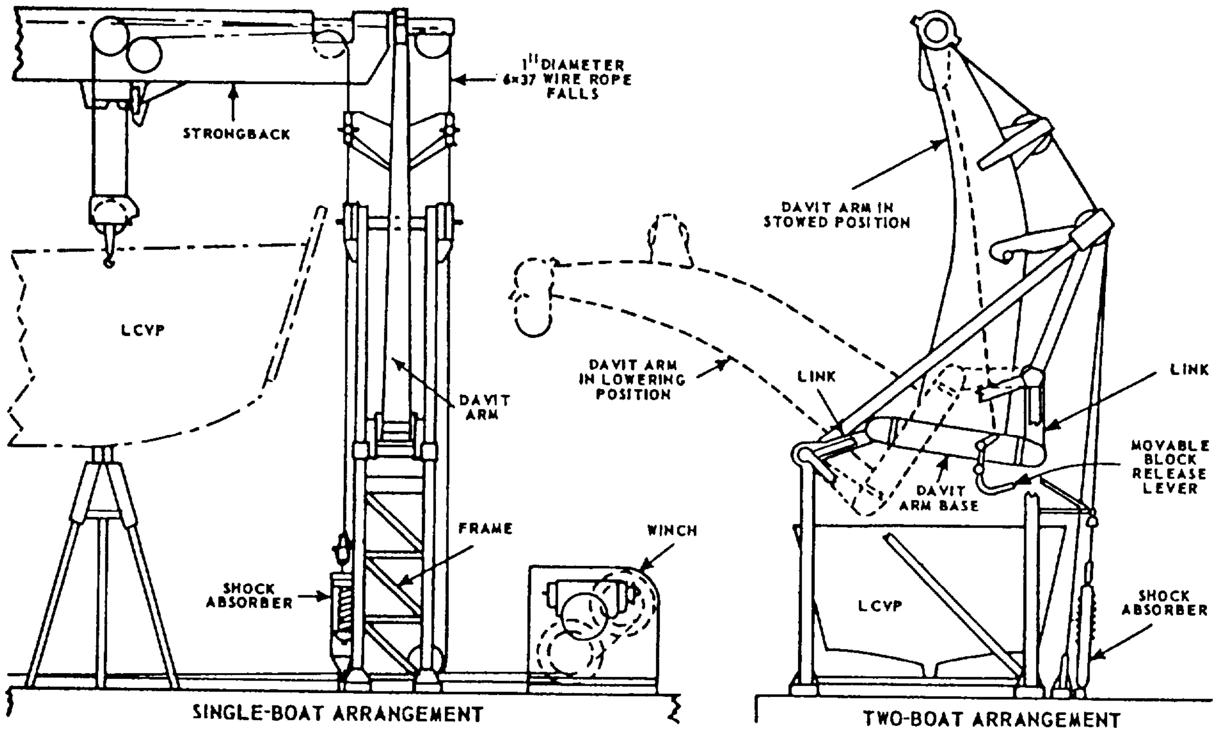

Figure 8-2.—Double-link pivoted gravity davit.

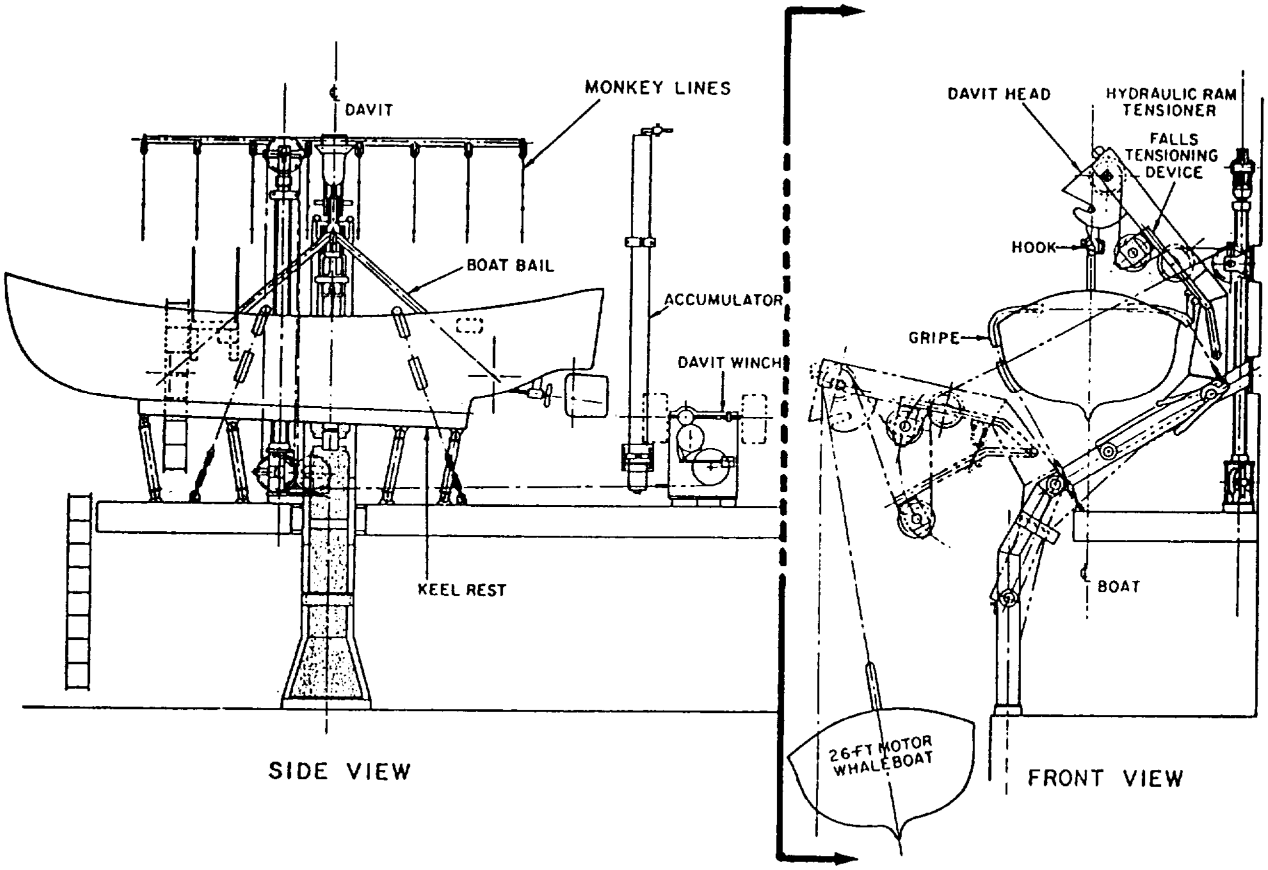

Figure 8-3.—Single-arm trackway gravity davit.

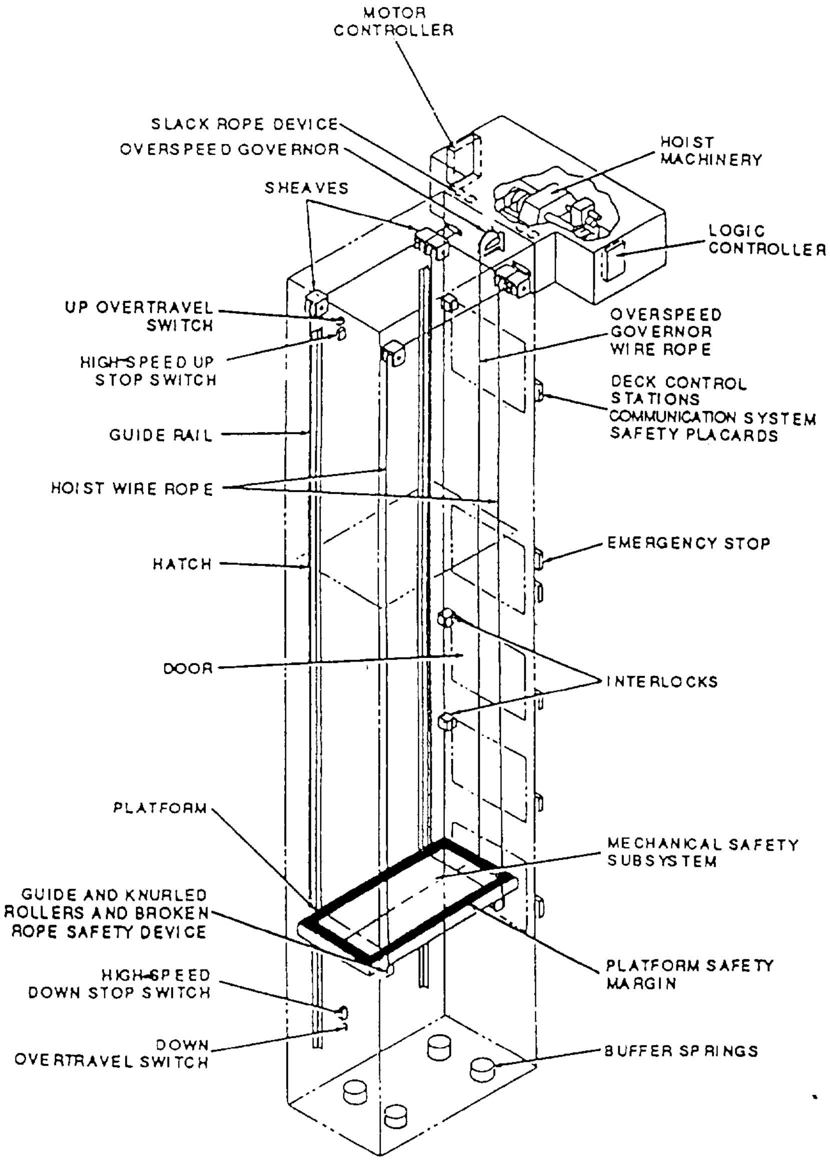

Figure 8-4.—Aircraft carrier weapons elevator.

read and heed any of the safety precautions and warnings like the following:

WARNING

Before starting disassembly of any piece of equipment, be certain the power is off and the switch is tagged. Do not re-energize any tagged circuit until safety of doing so is definitely established.

When you determine that a repair or replacement of part(s) will require disassembly, tag the system out. Remove any interfering guards or obstructions. To reduce the chance of dirt and other contaminants from getting into the works as the parts are disassembled, you must take the time to properly clean the machinery. Keep the dirt out of open gear cases and be sure parts are cleaned before reassembly. If the oil becomes contaminated, drain and flush the system with light oil and refill it with proper lubricant. Water in the oil will cause rust, and dirt can act as an abrasive to wear out the machinery. You must match marked parts that could be installed in more than one way so that you can return the machinery parts to their original position.

Components like winches and other actuating machinery are covered in considerable detail by their manufacturer's technical manuals. Any repairs to be done must be done according to the applicable technical manual as specified by PMS. You must complete the required PQS for this equipment. For more detailed information, refer to *NSTM*, Chapter 584, "Stern Gates, Ramps, Bow Doors, Turntables, and Water Barriers." Also, a copy of NAVSEA 0916-LP-018-5010, *Operation Manual for Bow Ramp System (U) LST 1182-1198,* may be very useful.

ELEVATORS

U.S. Navy shipboard elevators are either the electromechanical winch type or the electrohydraulic ram type. Elevators are classified by their functional use. The following designations are typical of elevators installed in Navy ships:

- Cargo elevator
- Weapons elevator
- Ammunition elevator
- Personnel elevator
- Medical evacuation (MEDEVAC) (casualty) elevator
- Aircraft elevator

Some elevators serve several functions. For example, aircraft elevators are used to move weapons, cargo, personnel, and support equipment. Weapons elevators can serve as cargo elevators and can be used to evacuate personnel casualties in a mass or medical emergency situation. Figures 8-4, 8-5, and 8-6 illustrate some of the types of elevators aboard U.S. Navy vessels. Pay particular attention to the location of components and safety devices on each type of elevator.

The complexity of elevator systems is increasing and so is the degree of maintenance and training required to keep them operational. It is a must that you qualify and pass a PQS, Ordnance/Cargo Elevators, Operation/Maintenance. Only qualified personnel can work on elevators. When doing an elevator maintenance

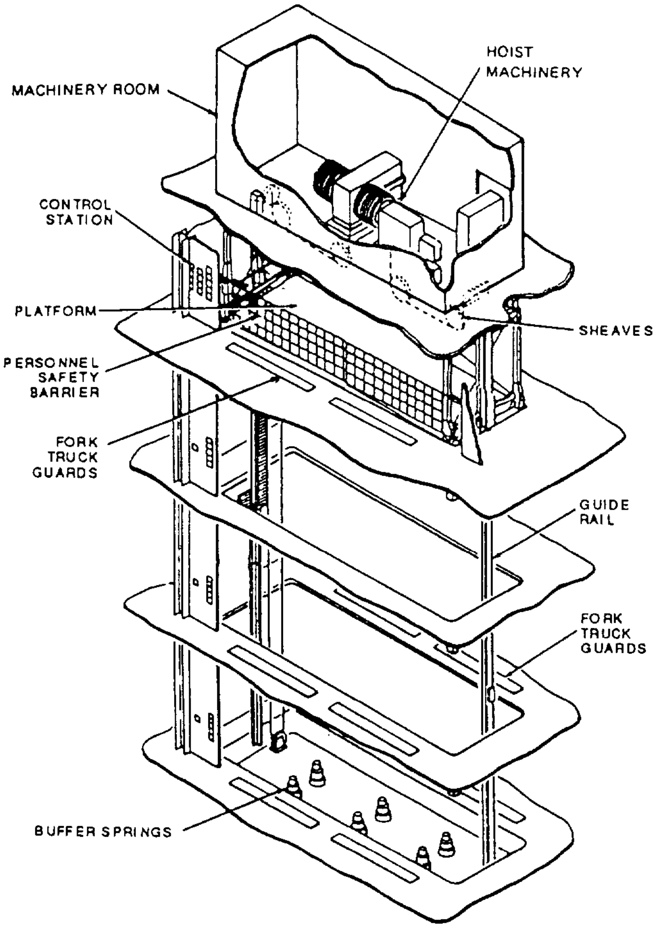

Figure 8-5.—Auxiliary ship elevator.

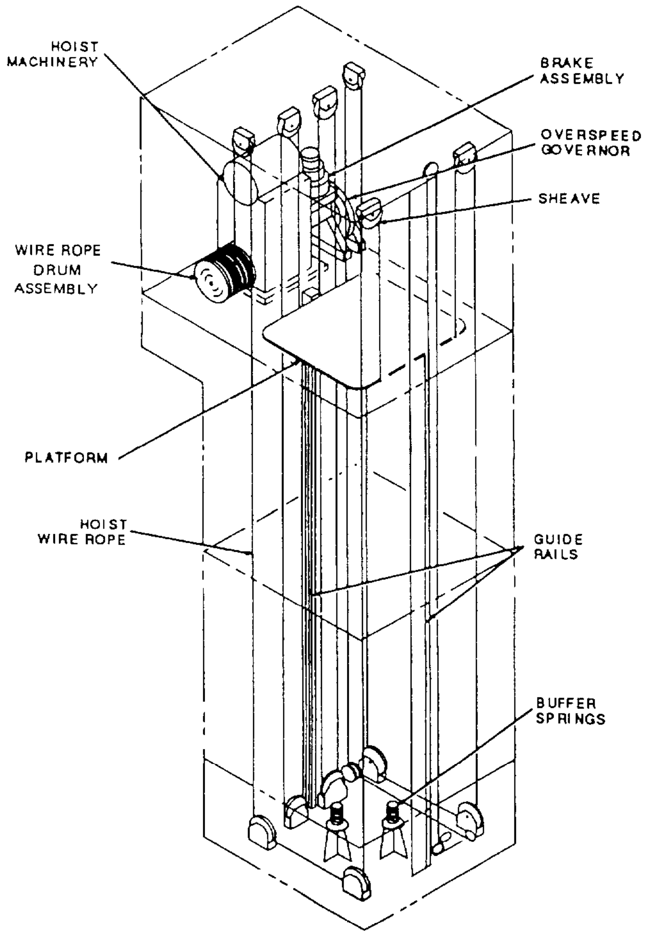

Figure 8-6.—Combatant (DD-963) elevator.

procedure, comply with all the procedures specified by the PMS.

CONVEYORS

The two types of conveyors the Navy uses for shipboard handling are gravity and powered. This section will deal with the general concepts of maintaining, troubleshooting, and repairing the conveyors within ship's force capability. When working on a conveyor, always follow the manufacturer's manual or the PMS. For more general information concerning conveyors, read *NSTM*, Chapter 572, "Shipboard Stores and Provision Handling." Figures 8-7, 8-8, and 8-9 are examples of some conveyors the Navy uses.

The difficulties most likely to be encountered during the operation of powered conveyors are not due to a malfunctioning of the mechanical equipment, but to the electrical equipment and the related interlocks. The following list contains common conveyor troubles that you may experience, the probable causes, and remedies for each of the troubles listed. The cause for improper operation is best diagnosed with adequate testing equipment and a thorough understanding of the complete system. Remember that with any electrical problem, you will need the help of an Electrician's Mate, who is fully trained for electrical work

Trouble	Probable Cause	Solution
Conveyor will not start.	Power fails.	Determine and correct cause of power failure.
	Main line fuse is blown.	Replace fuse.
Conveyor will not hoist.	Selector switch or switches are improperly set.	Check and reset selector switches.
Conveyor will not lower.	Selector switch or switches are improperly set.	Check and reset selector switches.
	Loading/unloading platform is set in horizontal position.	Reposition platform in either stowed or decline position.
Conveyor runs continuously when set at INDEX.	Limit switch is inoperative.	Adjust limit switch to actuate when bell crank passes.

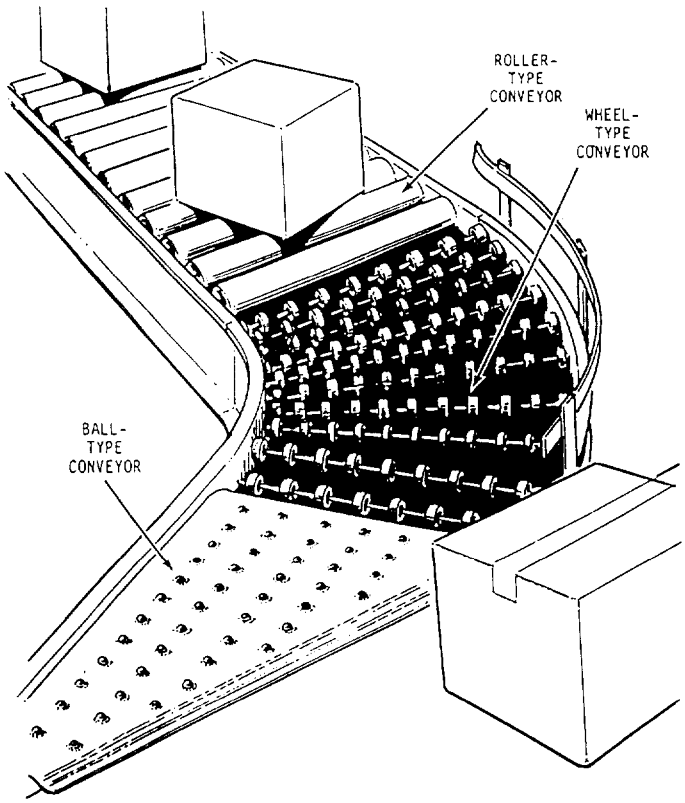

Figure 8-7.—Gravity conveyor.

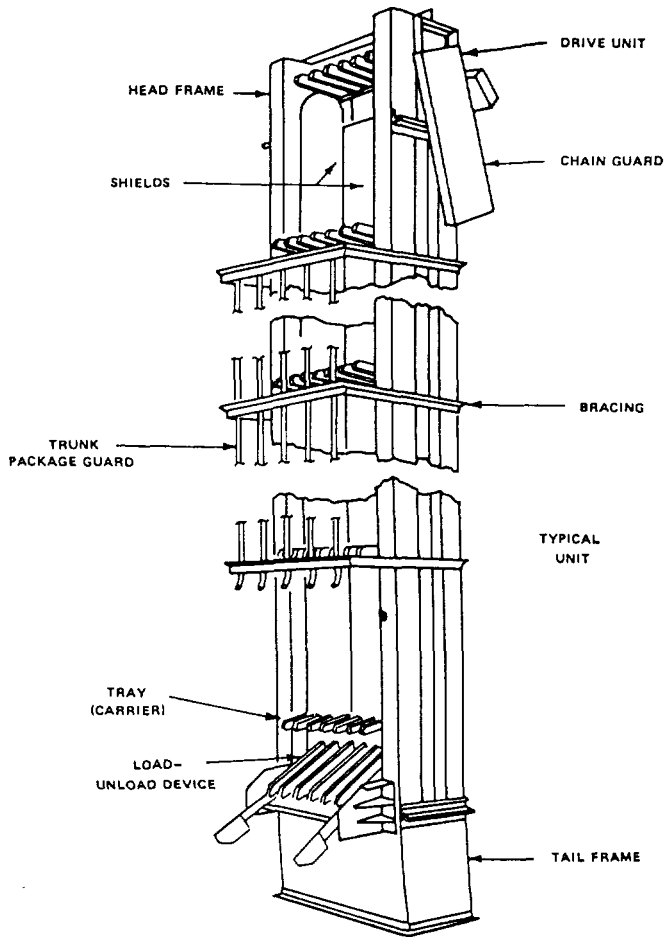

Figure 8-8.—Vertical conveyer, package, tray type.

For general maintenance and repair, always follow the requirements of the PMS. If the conveyor has been out of use for some time, inspect and service it before use, even if the maintenance period has not elapsed.

CRANES

Before you begin to adjust, repair, or do inspections on a crane, the following precautions must be observed and implemented as applicable:

1. The crane to he repaired must be positioned in a location where it will cause the least interference with other cranes or ship's operations.

2. The boom must be placed in the stowed position when work on the topping system is to be accomplished.

3. All controls must he placed in the OFF position.

4. The power supplies must be de-energized and the power supply breaker (in the OFF position) must be tagged DANGER, except as required for testing or adjustments.

5. Maintenance may be performed on energized electrical equipment only when specifically authorized by the commanding officer.

6. After completion of adjustments or repairs, the crane should not be restored to service until all guards have been reinstalled; safety devices are reactivated; maintenance equipment is removed; and all required testing is completed.

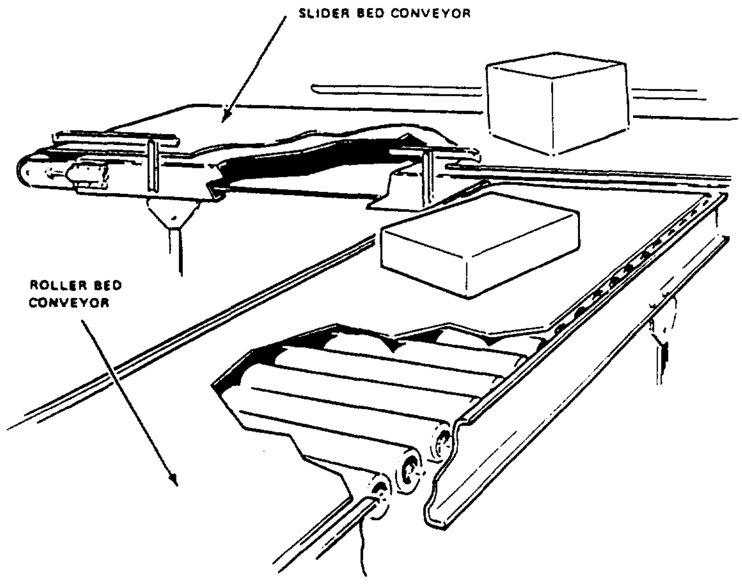

Figure 8-9.—Powered belt conveyor.

7. Maintenance on cranes should be performed only by formally qualified personnel, unless authorized by an authorizing officer on a single case basis for unusual repairs.

You must do all the maintenance requirements according to the instructions provided on the applicable MRCs. If the MRCs do not exist for a particular piece of equipment, your supervisor or you should institute interim maintenance according to the manufacturer's recommendations.

The following maintenance items should be included in the crane PMS package:

- Lubrication
- Safety inspection
- Lube oil maintenance
- Wire rope
- Brakes
- Instrumentation
- Electrical

For more general information on crane maintenance, repairs, and inspections, read ***NSTM,*** Chapter 589, "Cranes." Your ship should have a copy of the manufacturer's technical manual for in-depth individualized information of your ship's crane.

DUMBWAITERS

A dumbwaiter is a semiautomatic electro-mechanical hoist operating in a structural trunk. The car of a dumbwaiter is arranged to carry ship's stores of varying weights and package sizes. Figure 8-10 illustrates the parts and controlling mechanisms of a dumbwaiter.

You should inspect the dumbwaiter car and hoist every 3 months. Check the condition of the load cable (it could be a chain or wire rope cable), motor brake, friction clutches, overtravel limit devices, door interlock control switches, and safety devices. You must follow the manufacturer's manual or the procedures specified by the PMS when making repairs. You are required to complete a PQS for this equipment. For more general information, read NSTM, Chapter 572, "Shipboard Stores and Provision Handling."

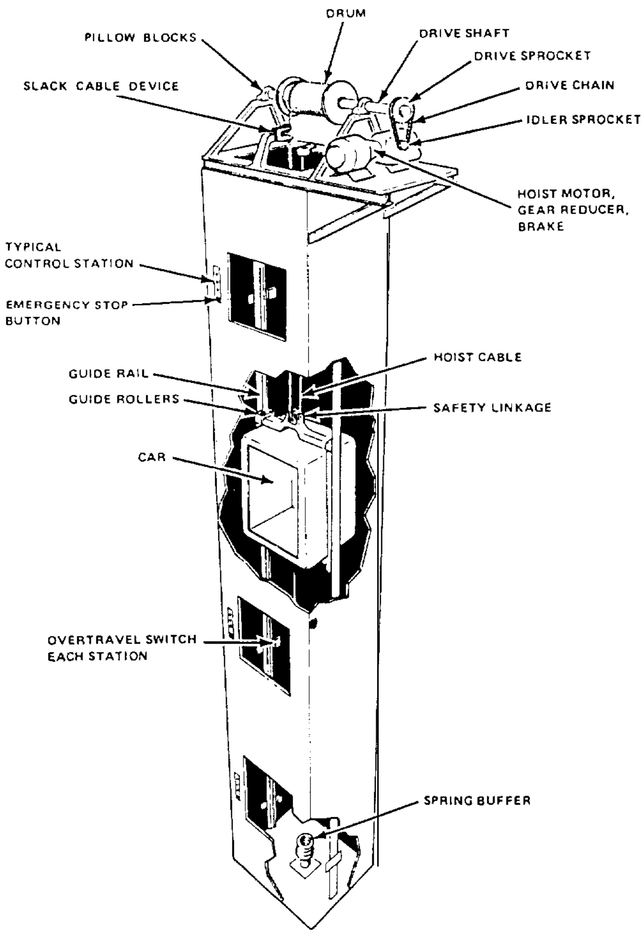

Figure 8-10.—Dumbwaiter.

ESCALATORS

Only aircraft carriers have escalators aboard, and each aircraft carrier has two escalators. Each is chain driven by a horizontally mounted worm gear machine. An escalator can operate in either direction and is designed to operate at a speed of 120 feet per minute, carrying flight personnel at the rate of 44 persons per minute. For full details of this equipment, read NAVSEA 0316-LP-020-7000, *Shipboard Escalators (Aircraft Carriers).* You must complete the required PQS for this equipment. When making repairs, follow the necessary safety precautions and the procedures specified by the manufacturer's manual or the PMS.

SUMMARY

This chapter has provided you with some general information on the maintenance and repair of auxiliary machinery. For you to do your job properly, you must be totally familiar with each piece of machinery; you must complete the required PQS; and you must know where ‘to find additional information on repairs and safety. In your work center PMS Manual 43P1, under the Maintenance Index Page, each piece of equipment has reference publications or publications for maintenance and repairs. You should check your equipment with the reference publications to make sure they are the right references. If you find an error in these references, you should submit a feedback report as soon as possible.